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ABSTRACT

Cognitive development as it progresses from concrete to abstract thinking is discussed as it relates to adolescent youth and the early secondary curriculum. Piagetian tests administered to a group of freshman and sophomore high school students revealed that many had difficulty with those scholastic activities requiring formal reasoning. Three curriculum areas--algebra, English, and history--are examined as subjects in which these students need the abstract reasoning powers they lack. It is emphasized that teachers must understand the processes involved in moving a student to the formal operational stage of thinking. Maturation, social interaction, experience, and equilibration are identified as factors facilitating this development. The implications for secondary education are pointed out, and recommendations are made for developing a curriculum that will provide an opportunity for this necessary cognitive growth. (JD)

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Adolescent Thought: Curriculum Implications

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Piaget's theory about the development of cognition has had a marked impact on curriculum and instructional attitudes within the last decade. Educators have begun to use Piaget's theory as a framework for examining curricular practices and for developing educational approaches which more closely match the level of cognitive ability at which children are operating.

Some of the most interesting educational applications of Piaget's theory involve the transition from pre-operational to concrete operational thought during the elementary years and the transition from concrete operational to formal operational thought during the secondary years. Much more curricular work has been done at the elementary than at the secondary level, but the need for examination of curriculum is great at both levels.

This article reports the results of a study of the formal operational reasoning of 84 high school students. Then it analyzes current curricular practices in secondary education and notes that the high school curriculum seems to require attainment of formal operational thought for success. And, finally, it presents recommendations for curricular changes.

Assessment of Formal Thinking Skills

The majority of experimental studies conducted with adolescents have been based on the clinical method involving the time-consuming process of individual interview and analysis of response.

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In this study it was felt that a more simple approach using a group process with a pencil-and-paper instrument would permit a broader application of measurement.

Five areas of testing were developed with three tasks included because, as Piaget states, "The beginning of the formal operational stage can be noted when the conservation of volume is attained" (Inhelder & Piaget, 1958). The three conservation tasks were: 1) water displacement using a clay ball dropped into a jar. Students were to state which shape would cause the water to rise higher and to explain their answer; 2) a drawing of a jug 1/3 full of water. The students were to draw a line representing the water line of the same jug tilted; 3) a drawing of test tubes to again indicate water displacement. This task examined the displacement of water by weight rather than by shape. Again an explanation was requested.

Piaget suggests three areas of formal thought: propositional, combinatorial, and proportional. The second section of the assessment measured propositional logic which is demonstrated through "if . . . then" reasoning, keeping several variables in mind. Piaget states that propositional logic appears to be one of the essential conquests of formal thought (Piaget, 1972). This level of logic is evidenced by the capacity to study statements and propositions rather than objects visible or immediately represented. Combinatorial logic, the third area, requires the recognition of several dependent and independent variables and the elimination of irrelevant variables. This system of thinking permits the combining of propositions. The fourth section of the

assessment, proportional logic, was measured through the use of mathematical problems using ratio. This is the "capacity for reasoning and self-representation according to two reference systems at the same time" (Piaget, 1973).

The last area of the test was based on one of Piaget's earliest works. In this volume, Piaget examined the uses of conjunctions in children's speech. He felt that, though conjunctions were present at an early age, they were not used correctly until much later (Piaget, 1928). Three conjunctions were used in this section: because, therefore, and although. The students were asked to compose sentences using each of these conjunctions. Three incomplete sentences for each conjunction were also given, which the students were to complete.

The test was administered in the Spring, 1977, to 84 Freshman and Sophomore students in a private denominational high school in San Joaquin County. The subjects represented a heterogenous group various races, socio-economic, and intellectual levels. The test was read orally to each group to insure that it was measuring logic rather than reading ability. The assessment was administered to the entire ninth and tenth grades.

The test was scored with a total of 30 points possible, allowing two points for each task. Most tasks could be subdivided into two separate responses with one point awarded for each part. The language section was scored by allowing one point for each composed sentence and 1/3 point for each sentence completion.

The California Test of Basic Skills, administered during

the previous Fall, was compared with the scores obtained on the Piaget assessment. The subsections in Reading and Math of the CTBS were used separately and in combination for a total score. The Piaget assessment score was also separated to compare the validity of the language section to the four areas of logic: conservation of volume, propositional, combinatorial, and proportional logic.

There was a significant correlation between the Piaget assessment and the CTBS (Piaget-- Total r=.68). There was no significant difference between the correlation of the reading and math subtests with the Piaget test. The logic sections of the assessment showed a correlation of r=.63 to the total CTBS. The language portion was less significant at r=.49. There were no significant differences in either grade or sex to performance on the Piaget assessment or the total CTBS.

The sentence structure portion was handled with the most success, with 324 correct responses from 504 possible, representing approximately 2/3 of the sentences written correctly. This section had a very low correlation with the rest of the assessment (Logic-- Lang. r=.31) and does not necessarily measure formal thinking. Conservation of volume was second in number of correct responses, with an average of 49%. Propositional logic was next with 38% correct. Combinatorial logic demonstrated a less successful level of thinking with an average of 30%. Proportional logic indicated an even wider discrepancy, with 24% correct responses. Scores ranged from 8 - 25 in grade nine, and 3 - 27 in grade ten. Median score for ninth grade was 13/30, in

tenth grade, 15/30. With the subtraction of the language portion from the assessment, the average score was 12/24 for grade nine, and 11/24 for grade ten.

The distribution of scores would indicate that a majority of these students was not functioning on the formal operational level. A surprisingly large number of both ninth and tenth grade students were unable to handle conservation of volume, the last conservation task to be attained on the concrete level. The results of this assessment suggest that many ninth and tenth grade students have difficulty with those scholastic activities requiring formal reasoning.

Current Curricular Practices

Little attention has been directed to the adolescent student and the educational implications of formal operational thought. What work that has been conducted with formal operations has been almost exclusively in the area of science. This concentration is understandable in that formal thinking "provides the basis for elementary forms of scientific thought" (Piaget, 1972). However, as the content of the entire high school curriculum is examined, it is evident that formal abstract thinking is a prerequisite for success in almost every secondary subject. Three curriculum areas will be examined: algebra, English, and history.

Algebra is the most explicit example of the application of formal reasoning. It depends on proportional thought and uses a set of symbols for symbols. The student must keep several variables constant while considering the transformation of other variables. S/he must also work through processes which involve

manipulation of different variables resulting in different solutions. Algebra's dependence on positive and negative numbers requires the mental processes which comprise hypothetical-deductive reasoning. It is usually not until adolescence that children can deal with simultaneous equations in two or three unknowns (Elkind, 1976).

As one examines the skills necessary for mastery of English grammar, the necessity of formal thought is also evident. The interpretation and application of abstract rules involves analysis, discrimination, and synthesis, all of which require sophisticated reasoning. The newer approach of structural linguistics, likewise, calls upon higher levels of thought process and often is more complex and abstract than traditional grammar. Piaget's earliest work in development of thinking skills deals with sentence structure, particularly the usage and conceptualization of conjunctions (Piaget, 1928).

Likewise, other components of the English curriculum such as literature, critical reading, inferential comprehension, and expository writing are equally demanding of the use of formal thinking. The traditional analysis of poetry, especially of figurative speech such as similes and metaphores, requires the understanding that the same proposition or statement can have different meanings. This is a formal reasoning skill, as is the comprehension of analogies and of proverbs. The formal thinker is able to represent his own and other's feelings and thoughts. He can conceptualize his own mental processes. This capacity has been referred to as reflective

intelligence and is prerequisite to the analytical reading that comprises the essential part of a literature program (Elkind, 1976).

History, by its very nature, is far removed from the immediate experience of the student. Not only is the action very distant in time, but the student is confronted with situations which envelop the inner motives of people who lived in earlier times, in other geographic areas, and vastly different cultural environments (Lovell, 1971). Concrete thought implies manipulation of concrete objects within the student's immediate environment, which would preclude understanding of cultures far removed in time and space. It is only during the formal reasoning stage that young people grasp the true extent of geographical and celestial space, and of historical time (Elkind, 1976).

Students who have not yet attained formal operations by grade nine or ten will be in considerable difficulty in their study of algebra, English, and history. There has been some research demonstrating a positive relationships between attitudes toward subject matter and level of logical thought (Lovell, 1971). It does seem reasonable that the attitude of students toward a subject may be related to their proficiency in that area.

Most teaching in high school of the three subjects under discussion is in the form of lecture or exposition. This is figurative teaching with little student interaction. The teacher lectures, explains, and questions (Elkind, 1976). Nearly all the action is on the verbal plane. It is the ability to deal with verbal

logic which distinguishes the formal from the concrete thinker. Therefore, the less than formal thinker is going to miss much of the application of the subject matter, even though the lecture is well organized and presented.

Too often the high school subject area specialist assumes that someone else has provided the concrete experiences and action-learning necessary for horizontal strengthening and vertical movement of cognitive development. As research has indicated, age or grade-level does not determine stages of cognitive development.

Recommended Curricular Changes

An understanding of the processes involved in moving a student to the formal operational stage is imperative. There are a number of factors which facilitate this movement. Maturation, social interaction, experience, and equilibration are those given by Piaget as necessary for learning. Without maturation, instruction on a higher level is of little value, but the teacher cannot wait for maturation alone. Social interaction and experiences are within the domain of the teacher to provide. Experiences on the student's level but which contain enough of the unknown to be a challenge will perhaps cause discomfort leading to an attempt at equilibration by the student. As s/he works to bring her/his knowledge into balance, learning and growth will take place. The teacher's role, then, is to provide an environment both familiar and novel, comfortable and uncomfortable. This will produce an environment where students can move into formal operational thinking.

Learning occurs when the student can interact with his learning environment. Concrete experience is the basis for development of formal thought (Renner, Stafford, Lawson, McKinnon, Friot, & Kellogg, 1976). Chiappetta (1976) states, "Instruction , . . needs to be concrete in nature in order to match the intellectual competence of the majority of students. . (it) . . must emphasize the use of real objects and events which the learner can interact with on a first-hand basis."

Creative teachers of all subject areas will spend considerable time in developing activities which utilize the active involvement of the student. They will be aware of the interests and the social milieu of the student in order to provide learning experiences which match these.

Math teachers should determine the operational level of students so that the material presented will relate to the student's cognitive skills. An attempt to provide operative learning through horizontal elaboration is important. Experiences involving simple proportional logic with objects builds understanding relationships. Measurement activities using real tools and objects, making comparisons, using symbols for measurement terms, using objects to demonstrate fractional representations, are all ways to introduce understanding of proportion. Multiplying and dividing with real objects also provide a foundation for algebraic concepts. The importance of the student's working with manipulative materials and not just with symbols is a main premise of a Piagetian approach to math instruction (Elkind, 1976).

English and history should be developed from the proximity and interests of the students. The immediate concerns of the class can be incorporated into study that can establish relationships with people of other cultures and times who had similar or contrasting problems. Small group interaction and joint involvement create interest and also allow for a sharing of the reasoning which stems from different operational levels.

The basis of learning consists of the enlarging of schema and the building of new structures from previously constructed schema (Piaget, 1973). The teacher's prime responsibility is to provide opportunity for establishing relationships between whatever content material is being presented and the cognitive structures with which the students are functioning.

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